Crushing Trauma and Its Aftermath

Crush Injury
Crush Syndrome
Compartment Syndrome

EMERGENCY MEDICAL SERVICES AGENCY
LOS ANGELES COUNTY

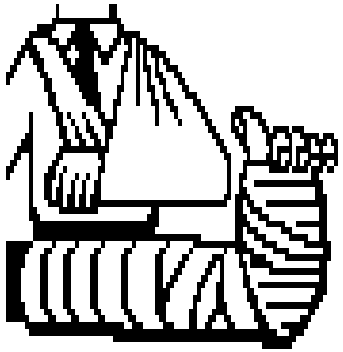
Crushing Mechanisms

- **Building & structure collapse**
  - Earthquakes
  - Explosions
- **Motor vehicle accidents**
  - Entrapment
  - Direct impact
- **Lack of spontaneous movement**
  - Deep sleep
  - Coma

Crushing Force

- External crushing force applied to body
  - High pressure short duration
    - *leg(s) slammed between two bumpers*
  - Low pressure long duration
    - *partially buried in collapse or cave in*
  - High pressure long duration
    - *generally results in amputation or death*

Involved Anatomy



- Upper extremities & pectoral girdle
- Lower extremities & pelvic girdle
- Other body areas generally result in immediate death
  - Head
  - Abdomen
  - Chest

Crush Injury
Cellular Response

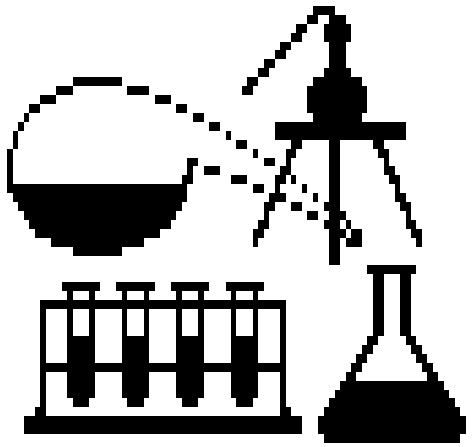
- Damage results in loss of cell membrane integrity
  - Intracellular contents spill into surrounding tissues and spaces
  - Histamine causes vasodilation & increased capillary permeability
- Continued pressure impairs circulation
  - Local tissue hypoxia
    - Anaerobic metabolism
  - Build up of cellular toxins in injured tissues
    - Lactic acid, uric acid, Potassium, Phosphates, Myoglobin

Crush Syndrome
Vascular Response

- Crushing pressure sustained
  - Body adapts to decreased vascular space
- Crushing pressures released
  - Blood flows into tissues (re-perfusion)
    - redistributive hypovolemia
    - wounds in crushed limb may begin to bleed
- Chemicals & toxins enter systemic circulation

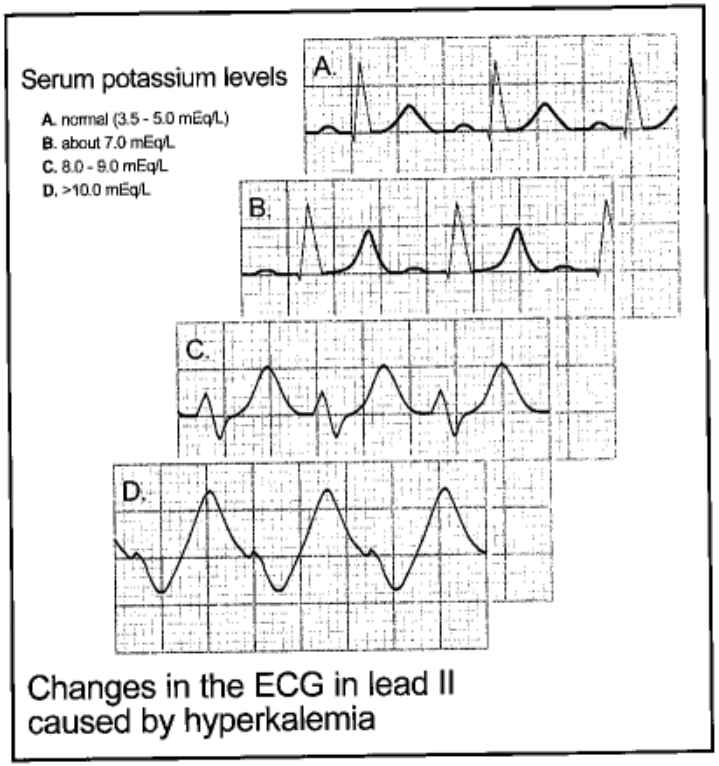
Crush Syndrome
Systemic Response

- Cardiovascular shock
  - Third spacing - fluids leave damaged vascular space
- Blood chemistry is altered
  - Decreased pH (increased acidity)
    - Increase of Lactic acid, Uric acid
  - Hyperkalemia (increased K^+)
  - Hyperphosphatemia
  - Hypocalcemia
  - Increased myoglobin in blood



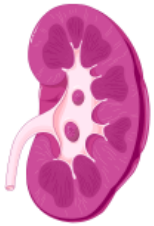
Crush Syndrome
Cardiac Response

- Hyperkalemia
  - ECG changes
    - peaked T waves
    - widened QRS complex
    - disappearing/absent P wave
  - Cardiac dysrhythmias
    - heart blocks
    - V-tach
    - V-fib
    - asystole

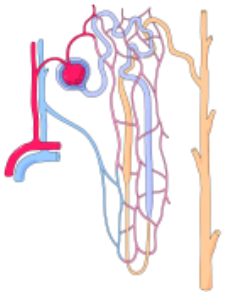


Changes in the ECG in lead II caused by hyperkalemia

Crush Syndrome
Renal Response



- Myoglobin
  - Small amounts normally filtered out through kidneys
  - Acidic environment causes myoglobin to precipitate out in kidney tubules
    - Urine becomes reddish-brown, cola colored
  - Causes kidney failure



Crush Injury/Syndrome Management

- "Treatment in the rubble"
  - Treatment should be started before pressure is released
  - Treatment may be hampered by the multi-causality incident and confined space of crush injury situations
  - Attempt to coordinate release of pressures with extrication specialists

Crush Injury/Syndrome Basic Treatment

- Manage airway - assume dust inhalation
  - Wipe out mouth with damp cloth
  - Administer O_2 via mask or provide dust filter mask
  - Albuterol by hand-held nebulizer for wheezing
- Start IV in unaffected limb
- Hydrate both adult and pediatric patients with 20ml/kg of NS

Crush Injury/Syndrome Psychological Support

- Panic & agitation is common place
  - "Don't leave me in here"
  - "Get me out NOW!"
  - Talk to patient
    - Patient may get ignored during technical aspects of rescue
    - Don't comment on future use or loss of limb
    - Field amputation by qualified MD may be necessary

Crush Syndrome Management

- Indications for treatment
  - Suspicion of hyperkalemia - ECG changes
  - Patient trapped longer than four hours
- Prehospital management
  - Albuterol 2.5mg/3ml NS continuous inhalation
  - Calcium chloride 1 gram IVP
  - Sodium bicarbonate IV Infusion
    - Add 1mEq/kg to first liter of NS after calcium chloride administration

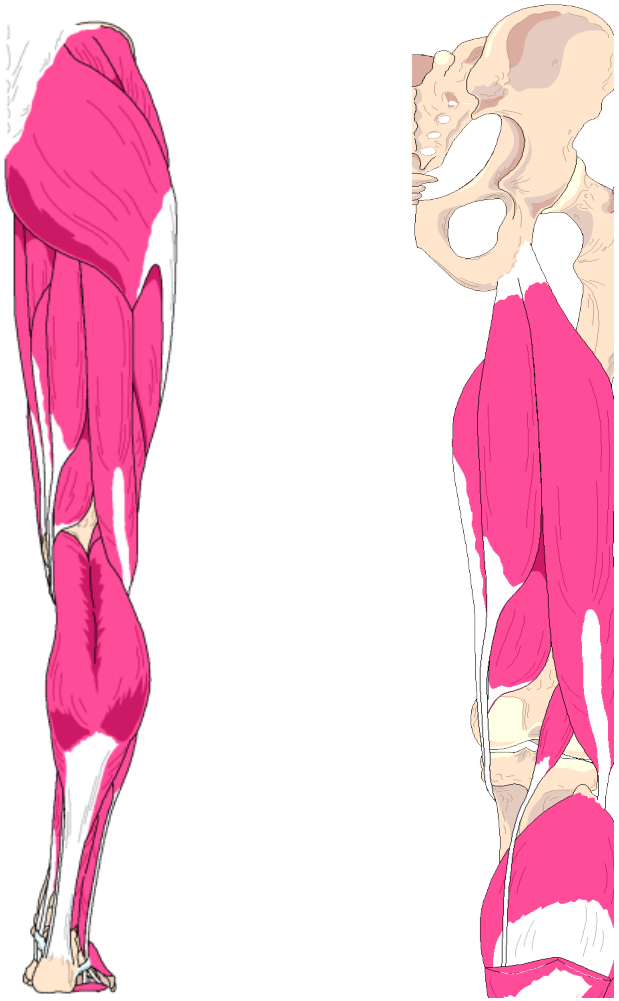
Assessment of Crush Victims - Post Rescue

- Marks on victim may be minimal
  - Keep limb(s) at heart level
  - Use non-compressive splints
- Paralysis/weakness of affected limbs
  - Mimics spinal cord injury
- Hypotension and tachycardia
  - Redistibutive hypovolemia
- Tachypnea
  - Metabolic acidosis

Assessment of Crush Victims - Post Rescue

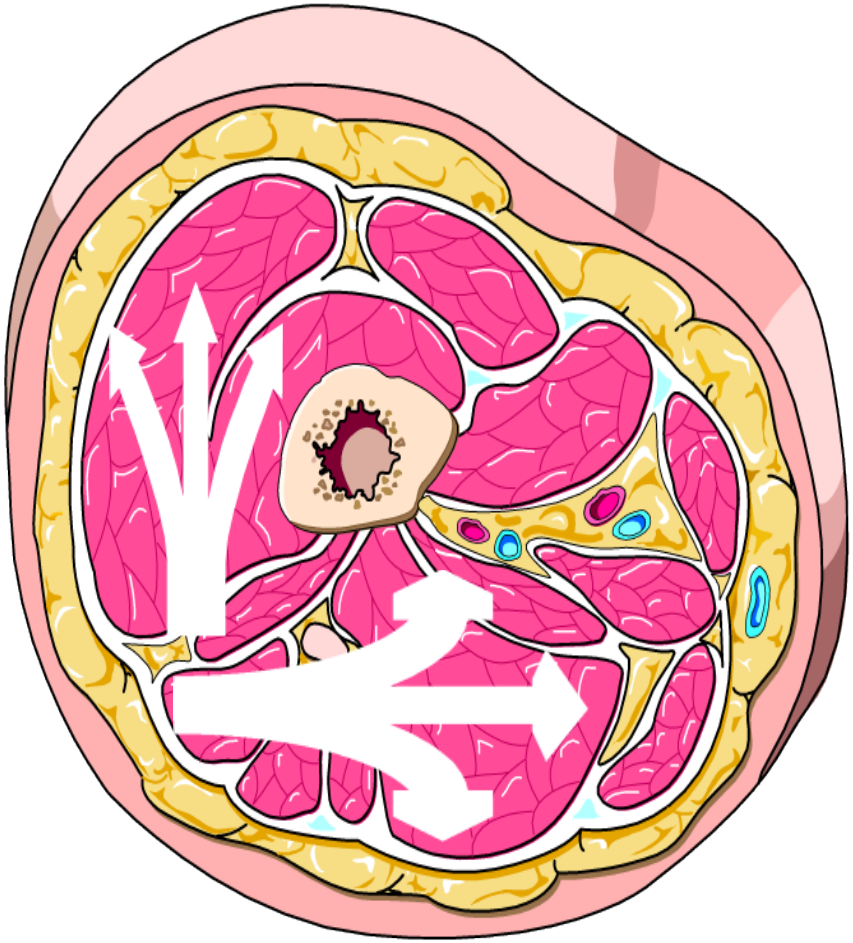
- Pain or paresthesia may increase
  - Consider Morphine 2 - 20mg IVP or 10mg IM
    - Pediatrics 0.1mg/kg IVP or IM
- Distal pulses may be absent
- Progressive swelling of affected area
  - Compartment syndrome

Compartment Syndrome



- Usually happens to large muscle groups such as quadriceps & gluteal muscles

Compartment Syndrome Pathophysiology



- Fluids re-perfuse damaged areas
  - Muscle tissues become swollen inside fibrous sheaths
  - Increased swelling results in increased pressure

Compartment Syndrome Signs and Symptoms

- General findings
  - Pallor
  - Paralysis
  - Pulselessness
  - Pain on passive stretch
  - Paresthesia
- Most significant findings
  - Pain on passive stretch
  - Sensory impairment

Compartment Syndrome Treatment

- Early recognition of developing emergency decreases disability
- Not treated in the field
  - Requires a fasciotomy to open the muscle compartment

Predictable Injuries and Complications

- Direct major organ injury
- Lacerations
- Fractures
- Dust inhalation
- Crush injury
- Crush syndrome
- Compartment syndrome